1-D Spherical Neutron Transport Equation

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Two methods are considered for solving the one-dimensional spherically symmetric neutron transport equation in a non-scattering media: 1) Corner-Balance using a mix of sub-cell averaging and downwinding across macro-cells and 2) Discontinuous Galerkin finite element using linear (and bilinear) bases functions for both test and trial spaces. Results are compared with the classical diamond-difference method.

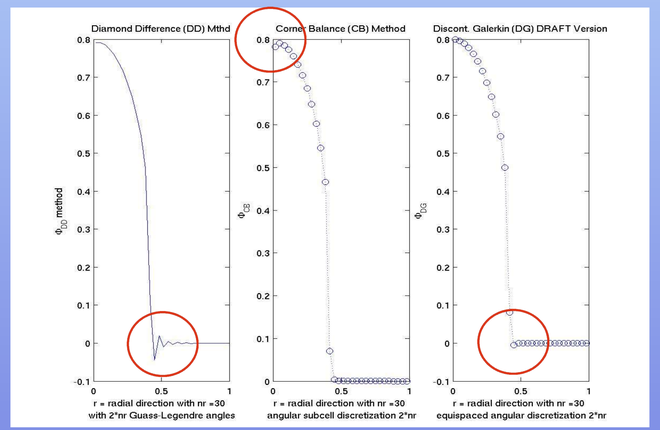
Introduction:

We solve the following equation

$$\frac{\mu}{r^2}\partial_r\left(r^2\psi\right)+\frac{\left(1-\mu^2\right)}{r}\partial_\mu\psi+\sigma\psi=q$$

(1) by modifying the closure equations of the diamond difference method for solving the neutron transport equation, and sub-dividing cells into 'sub-cells' or 'corners',

(2) by considering the weak form of the equation we develop a cell-centered discontinuous- Galerkin Finite Element method.

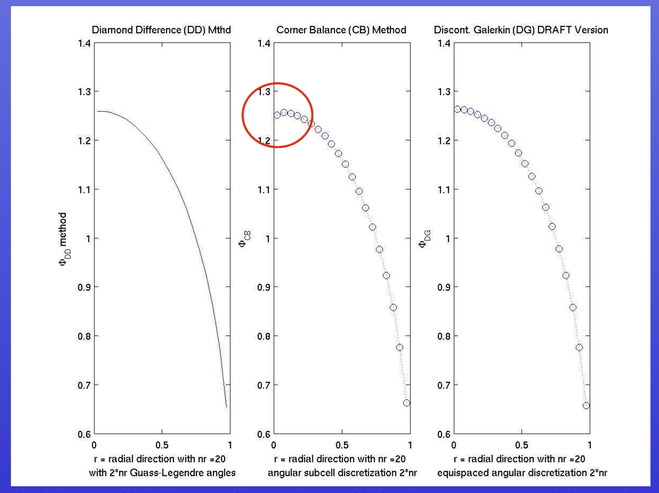


Results:

Two test problems were considered to evaluate and compare the performance the methods:

A. Single (absorbing and emitting) homogeneous media with vacuum boundary conditions.

B. Mixed media problem modeling a neutron source encased in a highly absorbing material under vacuum boundary conditions.



Discussion:

Results above are reported as the neutron flux.

$$\phi(r)=\int_{-1}^{+1}\psi(r,\mu)\;d\mu$$

The are three important characteristics considered here

- **accuracy (reported below as order of local truncation error)**
- **avoiding a "flux" dip at r= 0**
- **strict positivity and minimizing "unphysical" oscillations**

	Diamond Diff. (DD)	Corner Balance (CB)	Discont. Galerkin (DG)
Local Truncation Error	2nd	1st	2nd
avoids "Flux" dip at r = 0	no	no	yes
maintains positivity	no	yes	almost

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